WORK PLAN

FOR WATERSHED PROTECTION AND FLOOD PREVENTION

PRAIRIE CREEK WATERSHED

Vigo County, Indiana

OUR SOIL ★ OUR STRENGTH


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Agriculture
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WATERSHED WORK PLAN

PRAIRIE CREEK WATERSHED

Vigo County, Indiana

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666) as amended.

Prepared by:

Vigo County Soil and Water Conservation District

With Assistance by:

U. S. Department of Agriculture, Soil Conservation Service

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SUMMARY OF THE PLAN

The Prairie Creek Watershed occupies an area of 19,095 acres in Vigo County, in west central Indiana.

The Vigo County Soil and Water Conservation District, project sponsor, has been organized about 13 years to assist farmers in reducing soil losses and excessive runoff. However, floodwater damages to agricultural land and improvements and impaired drainage continue to be major problems. Once productive farmland is now worthless as a result of these increasing problems. More comprehensive projects must be employed to expedite this work.

Floods occur on the average of three times per year during the cropping season. Under present conditions 1332 acres are flooded by the 50-year storm. In addition, 255 acres of drainage outside the flood plain is dependent upon the main channel. Frequent overflows interrupt farming operations and prevent full use of the flood plain acres. It is the expressed desire of the Sponsoring Local Organization to reduce flooding and impaired drainage damages to the extent feasible. Local sponsors request damage reduction to at least once in five year cropping season frequency.

An accelerated land treatment program and structural works of improvement are necessary to bring about the desired level of protection to the damage area. The structural measures proposed will include three floodwater retarding structures, 1.3 miles of multi-purpose drainage and flood prevention channel improvement and 3.6 miles of flood prevention channel work.

There are 99 district cooperators and 44 basic farm plans within the watershed. A total of 47 farm operators will benefit from direct flood reduction benefits on their farms. Actual reduction of damages to crops, pastures and farm facilities will accrue in addition to the benefits possible from the more intensive use of flood plain land. A major benefit from flood reduction will accrue to county and state road systems. This benefit is estimated to be $6,500 annually. Secondary and incidental benefits, as well as drainage benefits, will also be realized by the farmers and residents of the entire watershed.

The estimated total primary benefits are $34,447, which includes: $19,470 flood reduction benefits from the proposed structural program; $6,726 drainage benefits from the channel improvement in one reach; $6,576 more intensive use; and $1,675 changed land use benefits. The structural measures will provide an annual benefit of $34,447 and will cost annually $23,608, thus providing a benefit-cost ratio of 1.5:1.

Total project costs are estimated to be $686,420. This includes $190,390 for land treatment measures, and $496,030 for the proposed structural works of improvement. The P.L. 566 share of the costs is estimated to be $455,200. This includes $36,400 for accelerating technical assistance for the land treatment measures, $409,140 for the cost of structural measures allocated to flood prevention, and $9,660, the P.L. 566 share of the costs allocated to drainage. Other than P.L. 566 costs include $153,990 for land treatment measure installation, $5,500 for the local share of the structural measure construction costs allocated to drainage, $68,580 for structural measure land easements and rights-of-way, and $3,150 for the administration of contracts. Farm operators will receive Agricultural Conservation Program assistance for the installation of land treatment measures.

Operation and maintenance of land treatment measures will be carried out by the land owners involved. The proposed Conservancy District will provide operation and maintenance of the proposed structural works.

DESCRIPTION OF THE WATERSHED

Physical Data

Prairie Creek Watershed is located in Vigo County in west central Indiana. It occupies an area of 19,095 acres (29.84 square miles) about 15 miles south of Terre Haute, Indiana.

This watershed, located in the northern part of the Wabash Lowland Physiographic Unit, is characterized by flat to gently rolling uplands with short, moderately to steeply sloping valley walls. The upper reaches of Prairie Creek and its tributaries and the lower reach of the main have narrow flood plains. The middle reaches are characterized by broad, nearly flat areas subject to frequent flooding.

Windblown sands and silts, resting on glacial drift, mantle the interbedded sandstones and shales of the uplands. Alluvial sands, silts, and clays occupy the narrow floodplain reaches. The alluvial soils of the broad, middle reach flood plains are underlain by sands, silts, and gravels. The latter were deposited when this part of the watershed served as an outwash channel for glacial melt waters. Alluvial soils in the lower reach of the main channel are underlain at shallow depths by shale.

Prairie Creek rises in the nearly flat upland till plain near the Town of Pimento, about ten miles south of Terre Haute. The creek flows generally in a southwesterly direction, and is joined by four small tributaries, one of which joins from the north, while the other three join from the east. Just north of the Town of Prairie Creek the creek flows in a

westerly direction to the Town of Vigo. The watershed area included in this work plan is bounded on the lower end by the north and south road passing through Vigo. Prairie Creek eventually flows into the Wabash River about four and one half miles southwest of Vigo.

Prairie Creek Watershed is about nine miles long and has an average width of about three and one half miles. The maximum elevation in the headlands near Pimento is about 620 feet above sea level while the minimum elevation at the channel bottom at the outlet is 548 feet.

Mean temperatures range from 29 degrees above zero in January to 73 degrees in July. The recorded extremes are 24 below zero and 110 above zero. The average date of the last freeze is April 22 and that of the first freeze is October 19. This allows for a 181 day growing season free from frost. Mean annual precipitation is 39.4 inches. The more intense rains usually come in the months of May and June. The minimum annual rainfall recorded at the Farmersburg station, near the watershed, is 28.7 inches while the maximum is 54.4 inches.

Economic Data

The U. S. Census of Agriculture, 1959, for Vigo County, shows the average size farm to be 213 acres with an average value for land and buildings of $232 per acre. General farming is practiced in the area with the major farm income derived from the sale of grain. Livestock ranks second in value of total farm products sold with hogs leading all other livestock.

Principle crops grown are corn, soybeans, wheat, oats, and hay. There are approximately 200 farms in the watershed averaging in size about 95 acres. About 10% of the farms are tenant operated. An estimated 23% of the farm operators have other income exceeding the value of agriculture products sold.

All of the land within the watershed is privately owned with the exception of 1320 acres owned by the Terre Haute Federal Prison.

There are three small towns within the watershed. Pimento is located on the eastern perimeter, and Prairie Creek and Vigo are in the western part of the watershed. A good system of interconnecting county roads, along with U. S. 41 and Indiana State Highway 63, provide easy access to any part of the watershed. The Chicago and Eastern Illinois Railroad crosses the eastern edge of the watershed.

Present land use conditions and future conditions, as anticipated after the project is installed, are shown in the following table. Present conditions are shown as "Without Project," future conditions as "With Project."

LAND USE - PRAIRIE CREEK WATERSHED

	Without Project			With Project		
	Floodplain	Upland	Total	Floodplain	Upland	Total
Cropland Acres	1,270	12,940	14,210	1,360	11,900	13,260
Grassland Acres	36	1,830	1,866	36	2,970	3,006
Woodland Acres	110	1,690	1,800	20	1,780	1,800
Idle Acres	24	550	574	24	233	257
Other Acres 1/	42	603	645	42	730	772
Total	1,482	17,613	19,095	1,482	17,613	19,095

1/ Includes farmsteads, roads, structural sites, and sediment pools.

WATERSHED PROBLEMS

Floodwater Damage

Floods occur on the average of three times per year during the cropping season causing damage to crops, fences, roads, and to the land. The total average annual floodwater damages, as determined by this report,

are estimated to be $25,299. Impaired drainage and flooding in Reach V has affected crop production to the extent that one year out of five there is a complete crop failure. Much of this area is idle and slowly reverting to poor quality woodland.

Frequent overflows interrupt farming operations and prevent full use of the flood plain acres. From farmer interviews and a comparison of similar flood free areas, it was determined that higher crop yields could be sustained and farm operation costs reduced.

Other agricultural floodwater damages consist of damage to fences and the cost of annual clean-up of accumulated debris on the overflow area before spring plowing.

Non-agricultural floodwater damages are mostly to road and bridges throughout the floodplain. Floodwater damages include undercutting of the road, destruction of the road bed and paved surface, damage to bridge abutments and road culverts. Debris and gravel lodge in the road ditches requiring clean-out and reshaping. Damages to the road net interrupt school bus traffic carrying farm children to consolidated schools. It involves extra travel around damaged area for farmers moving produce to market. Service traffic is interrupted and forced to detour to other roads causing unnecessary delays.

Indirect damage from floodwater in the watershed includes depreciation of land values, increased cost required to carry on normal operations during flood periods, cost of above normal maintenance to farm machinery as a result of working over scour areas and handling dusty crops during harvest, and disruption of travel and services as a result of inundated or washed out roads.

Sediment Damage

In Reach V the channel is filled to depths of from two to four feet with sand. The deposition of this sand is due to the lack of channel gradient and to lack of maintenance. In this reach the flood plain is relatively wide. The inherently poor drainage is aggravated by the lack of channel capacity. Some areas of the flood plain have been provided with tile drains, but the tile lines are inoperative due to clogging by soil particles and lack of adequate outlets. Flooding and impaired drainage damages are considered inseparable and no specific sediment damage has been evaluated.

Minor amounts of infertile overwash were found adjacent to the channels throughout all reaches in the watershed. These were in the form of very narrow natural levees and the damage was insufficient to warrant evaluation.

Erosion Damage

Approximately 70 percent of the upland portion of the watershed is in cropland. Sheet erosion rates are relatively high, being estimated at about 11 tons per acre for cropped areas. A carefully planned land treatment program which includes erosion reduction controls will effectively reduce this type of erosion when established. A change to less intensive land use on most of the upland areas unsuited to cropping practices will also bring about a reduction in sheet erosion.

Gully erosion was found on some of the steeper upland slopes. With proposed land treatment measures installed this type of erosion will not present any problem in design and cost of proposed floodwater retarding structures.

Upland erosion was not evaluated since land treatment measures will bring about the needed reduction, and they are considered to be justified

without evaluation.

Flood plain scour, the only significant form of erosion damage on the flood plain, occurs in Reaches III, IV, and V. Through these reaches a width of flood plain adjacent to the channel is usually scoured several times each year. This results in a 19% reduction of productivity annually on 6.4 acres, amounting to an average annual damage of $1066.

Problems Relating to Water Management

Impaired drainage, resulting from flat channel gradient and inadequate depth, exists in Reach V. On 550 acres of cropland, yields are poor and only in those years of below average rainfall can a profitable crop be harvested. There is need for an outlet channel with sufficient depth to permit the installation of proper tile drains to assure utilization of this area for agriculture.

The pattern of agriculture, crop rotation, normal rainfall distribution cycle and moisture holding capacity of the soils are such that irrigation is not expected to develop in the watershed in the forseeable future.

Within the watershed water for domestic and farm use, supplied by wells and farm ponds, is adequate.

Water for recreation and fish and wildlife purposes has been considered by the sponsoring local organization. Although these purposes may be incorporated into the proposed structures during design stage, no arrangements, at the present, have been made to include this purpose. Pollution is not a serious problem in the watershed streams.

PROJECTS OF OTHER AGENCIES

Prairie Creek is a tributary of the Wabash River. The U. S. Army Corps of Engineers in their overall comprehensive study of the Wabash

River Basin have proposed levees and channel diversion of Prairie Creek below the Town of Vigo. The proposed Corps project affects all of the watershed area involving flood plain areas common to both Prairie Creek and the Wabash River. No works of improvement are included in this plan or benefits claimed beyond the Town of Vigo. This plan is coordinated with the proposed plan of the Corps of Engineers.

BASIS FOR PROJECT FORMULATION

Project formulation, based upon the desires of the local sponsors, was to provide flood protection and erosion control to the broad fertile flood plain areas, roads, farm fences, and to provide adequate drainage in Reach V. It will also provide for stabilizing and balancing the family farm enterprise in the watershed.

Local interests requested the highest level of protection possible commensurate with feasibility. Combined effects of land treatment measures, floodwater retarding structures and various degrees of channel improvement were considered. To coordinate this plan with the proposed Corps of Engineers' Greenfield Bayou Project, no works of improvement were planned downstream from the Town of Vigo.

Alternatives with varying degrees of protection were evaluated. Five floodwater retarding structures were studied. One structure, on a tributary near the Town of Prairie Creek, was eliminated when interest for municiple water storage failed to materialize. Another one, farther down stream, controlling a drainage area of approximately two square miles, was omitted since it did not add to the overall net benefit or level of protection to the main flood plain.

Floodwater retarding structure numbers 1, 2, 3, and five miles of channel improvement, with a multiple purpose channel designed for drainage and flood prevention in Reach V, were found to meet the needs and

desires of the local people at the least amount of cost.

This project results in a level of protection of a five year average flood frequency during cropping season. No induced damages outside the watershed are anticipated.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

The initial step in flood prevention and watershed protection is the development of an effective land treatment program. It is necessary to increase the amount and rate of measures being installed to bring about the desired results. There are 99 cooperators and a total of 44 basic farm plans serviced within the watershed.

It is estimated that the application of the proposed land treatment measures will reduce damages in the benefited area approximately 3%. These measures are also essential to render effective, and as economical as possible, the proposed structural works of improvement.

Measures to be applied on the cropland of the watershed will be (1) conservation crop rotations, (2) grassed waterways, (3) diversions, (4) grade stabilization structures, and (5) tile and open ditch drains. These measures are for the purpose of controlling erosion and surface, as well as, subsurface water movement.

Measures to be applied to control water and soil losses on watershed pasture land will be (1) grassed waterways, (2) pasture planting, and (3) grade stabilization structures.

Land treatment measures for woodland, to reduce soil and water runoff, will be (1) livestock exclusion, (2) improved forestry practices, (3) sustained yield practices, (4) cultural practices, and (5) forestation.

Land treatment measures to be applied on land classed as idle and miscellaneous will be (1) diversions, (2) grade stabilization structures, and (3) tree planting.

Land now improperly utilized, either as cropland or idle land will be converted to pasture, woodland, and wildlife to reduce soil and water losses.

Structural Measures

The structural measures included in this plan, as shown on the Project Map, consist of three floodwater retarding structures and 4.9 miles of channel improvement.

The floodwater retarding structures will be earth fill dams with principal spillways of a reinforced concrete inlet and a reinforced concrete pipe conduit. Each of the structures has a two stage inlet to the principal spillway and a vegetated earth emergency spillway. These structures are designed to temporarily detain 2063 acre-feet of floodwater which is equivalent to 2.56 inches of runoff from the drainage area above the structures. The floodwater retarding structures will control 50% of the total watershed drainage area. Each structure contains a five year frequency runoff with moisture condition II between the low and high stage inlets. The total sediment pool capacity is 635 acre-feet with a total surface area of 121 acres. These pools are designed for a 50-year life. With the average depth of the sediment pools about four feet there is a good possibility of them holding water. The total installation cost of floodwater retarding structures is estimated to be $264,930. Figure 1 is a typical drawing of these structures.

Geologic and soil condition at the structure sites appear satisfactory. Sufficient and suitable borrow material is available. Prior to design detailed geologic investigations and soil mechanic analysis

will be made for each site. Sediment storage requirements, as estimated, are believed to be adequate for final design purposes.

The channel improvement in Reach II is to provide an outlet for the channel above. This portion of the channel is designed so that the five year cropping season storm flow will be within banks at the upper end of Reach II. Reach III and IV of the channel improvement are for flood prevention only. These two reaches are designed to carry the five year cropping season storm. Reach V is a multi-purpose channel for flood prevention and drainage. This reach of channel is also designed to carry the five year cropping season storm and, as planned will have adequate depth and capacity for drainage.

The channel in Reaches III, IV, and V will be straightened. Only minor realignment is planned in Reach II. The design data for channel improvement is shown in Table 3A. Figure 2 illustrates typical channel sections. The total estimated installation cost of channel improvement is $231,100. The cost distribution may be found in Table 2.

EXPLANATION OF INSTALLATION COSTS

Project Costs

The estimated-installation cost for all land treatment measures is $190,390. Technical assistance will be accelerated from P.L.566 funds in the amount of $36,400. The remaining cost of $153,990 will be from other funds. These costs include labor, materials, machinery, technical assistance, and costs related to the installation of the measures.

Installation cost for structural measures as shown in Table 2, includes construction, installation services, administration of contracts, and land easements and rights-of-way costs.

Construction cost is the Engineer's estimate of the cost of all materials and labor involved in constructing the structural measures. A 15% contingency is added to the estimated contract cost of floodwater

retarding structures. A 20% contingency is added to the estimated contract cost of channel improvement to defray any unexpected cost that might occur during construction. The cost estimates were based on a detailed estimate of quantities for each structure and reach of channel. The abstracts of bids of all P.L. 566 projects contracted in the state were analyzed to determine the unit prices which should be used in the cost estimate. These unit prices were then compared with unit prices now being used in the Engineer's estimates by the Soil Conservation Service Engineering Design Unit, located at Indianapolis, Indiana, and found to be consistent.

Installation services include engineering services and other services. Engineering services include all direct P.L. 566 and other costs for the services of engineers and geologists used in designing and installing the structural measures. Examples of engineering services are construction surveys and investigations, necessary inspection, installation assistance, preparation of plans and specifications, and similar services in carrying out construction. Other services include all overhead costs for structural measures, as well as, direct costs for installation services provided by other than engineers and geologists.

Administration of contracts includes all local costs for administration, legal, and clerical services incurred by the contracting local organization in carrying out contracts.

Land, easements, and rights-of-way include the following costs:

A. All expenditures made in acquiring land, easements, and rights-of way or their value as estimated by the local organization and the service.

B. All expenditures for the relocation or raising of private or county roads or permission to flood these roads.

C. All expenditures for lowering the underground pipeline in Reach IV and permission to construct the channel over it.

D. Relocation or reconstruction of fences.

E. Replacement or changes to bridges (no such costs are anticipated)

Floodwater retarding structure numbers 1 and 2 will cause intermittent flooding of county roads; however, alternate routes are available.

The cost of Reach V is allocated by Second Alternate Method as described on page 1132.1 of the Watershed Protection Handbook. The cost of Reach V allocated to flood prevention is $25,490 and the portion allocated to drainage is $16,710, as shown in Table 2A. The P.L. 566 share of the $16,710 allocated to drainage will be $9,660, and the local share will be $7,050.

The total cost allocated to flood prevention is $479,320; of this cost the P.L. 566 share is $409,140.

An estimated schedule of Federal and non-Federal obligations for the installation of the structural measures by fiscal years is tabulated below.

Fiscal Year	P.L. 566	Other	Total
1st	10,000	26,300	36,300
2nd	94,800	8,870	103,670
3rd	77,200	3,570	80,770
4th	63,800	31,490	95,290
5th	173,000	7,000	180,000
Total	418,800	77,230	496,030

Non-Project Costs

Non-project costs are not anticipated in the structural program. However, if during project installation, non-project costs are incurred, they must be borne by the sponsoring local organization as additional items not included in benefit-cost, cost allocation, or cost sharing computations.

Non-project costs include all additional costs resulting from changes of, or additions to, project works of improvement for non-project purposes or maintenance such as (1) altering a structure to permit its use as a roadway, (2) distributing and leveling spoil or disposing of excavated material primarily to improve land, (3) filling abandoned channels or depressed areas outside of the right-of-way or relieving local organizations of the responsibility of acquiring the necessary right-of-way, (4) constructing maintenance roads and associated culverts, (5) relocating or modifying planned works of improvement for the convenience of the sponsoring local organization.

EFFECTS OF WORKS OF IMPROVEMENT

The works of improvement, as outlined in this plan, will have significant effect on the floodwater damages that occur and will bring about needed improvements of the agricultural land within the flood plain.

Primarily, the monetary benefits justifying the proposed structural program are to the agricultural land. Non-agricultural benefits in the way of flood reduction benefits to roads and bridges will provide a saving to the county in highway maintenance costs.

The present frequency of flooding of the flood plain cropland and pasture averages about three times per year during the growing season. After project installation, this frequency of flooding will be reduced to one flood in five years in all reaches except Reaches I and II. In Reaches I and II there will be very little change in the degree of flooding from that under present conditions. Calculations indicate that there will be no adverse effects in these two reaches from the proposed works of improvement.

The present average annual area flooded amounts to 820 acres. With project, the average annual area flooded will be reduced to 180 acres. Under present conditions 1332 acres below detention structures are subjected to floodwater damages by the fifty year frequency storm. After project installation this size storm will flood only about 785 acres. Presently, the five year frequency storm floods 998 acres. After project, this size storm will flood approximately 155 acres, all of which are in Reach I and II. This is the area presently flooded in these two reaches by this same frequency storm.

The total average annual damage from floodwater and erosion, as determined by this study, amounts to $25,299. The total reduction attributed to this project is 79% of all damages.

Land enhancement in the form of more intensive use of present cropland and changed land use benefits will accrue to 845 acres as a result of the reduced frequency of flooding provided by the proposed measures.

Drainage benefits were estimated on 127 acres outside the floodplain where, under present conditions, drainage measures cannot be installed due to inadequate depth and channel capacity. An estimated 128 acres in this area, that is now tiled, will receive some benefits but were not evaluated.

The number of land owners directly benefited by the proposed flood reduction and drainage measures is estimated at 47.

PROJECT BENEFITS

The total annual benefits are estimated at $39,567, including: (1) damage reduction due to structural measures of $19,470, (2) benefits from more intensive use of present cropland of $6,576, (3) changed land use benefit of $1,675, (4) drainage benefit of $6,726, and

(4) local secondary benefits of $5,120.

Secondary benefits from a National viewpoint, were not considered pertinent to the economic evaluation. Secondary benefits include benefits from (1) the transporting, processing, and marketing of those goods and services that produce the primary benefits, and (2) the supplying of additional materials and services required to make possible the increased net returns which stem from installation of the project facilities.

Incidental recreation benefits to the sediment pools of the retarding structures were not considered. Due to the topography of the area, the depth of the water will average about four feet at the dam and would not be suitable for boating or fishing.

Intangible benefits will accrue with the installation of this project. These include benefits derived from the installation of land treatment measures by the farmers, which exceed the cost of applying such measures, and a benefit to the community as a whole by providing a more stable farm income, and make a significant contribution to community development.

COMPARISON OF BENEFITS AND COSTS

Benefit and cost comparison for the single unit of evaluation is shown in Table 6. Based on primary structural measure annual benefits of $34,447 and an average annual cost of $23,608, the benefit-cost ratio is 1.5-1. An additional benefit-cost ratio, computed by combining local secondary benefits of $5,120 with all other benefits, shows a benefit-cost ratio of 1.7 to 1.

PROJECT INSTALLATION

Land Treatment Measures

Watershed upland will be protected from excessive runoff and soil

erosion by the application of land treatment measures determined by land capability classification. These measures will be incorporated into basic conservation plans. Technical assistance for the planning and application of this work will be provided by the Soil Conservation Service. Technical assistance for the forestry measures will be provided by the Division of Forestry, Indiana Department of Conservation, in cooperation with the U. S. Forest Service. Technical assistance for land treatment measures under Soil Conservation Service will cost $40,090, of which $34,750 will be provided under authority of P.L. 566 and $6,340 will be provided by the regular P.L. 46 going program. Technical assistance for installing the forestry measures will cost $3,630, of which $1,650 will be provided under authority of P.L. 566 and $1,980 will be provided by the Indiana Department of Conservation. Land treatment measures will be installed by the landowners and operators.

The responsibility for the application of the land treatment measures will rest with the Vigo County Soil and Water Conservation District. Necessary technical assistance will be provided, work priorities will be established and follow up contacts will be made under the supervision of the District supervisors.

All land treatment measures will be installed prior to or concurrently with the installation of structural works of improvement. The sponsoring local organization will obtain agreements to carry out recommended soil conservation measures and proper farm plans from owners of not less than 50% of the lands above proposed floodwater retarding structures.

The need to store water temporarily and the need for land treatment has been received favorably by the Federal Prison Authorities. A letter from them is on file with the Sponsors and the State office of SCS.

Structural Measures

All works of improvement will be installed during a five year period. The first year may be utilized for securing easements and completing construction plans and specifications on contracts to be let the second year. In order to realize the most benefit from the structural measures, they will be installed in the following sequence:

1. Floodwater retarding structure No. 1
2. Floodwater retarding structure No. 2
3. Floodwater retarding structure No. 3
4. Channel improvement reaches II, III, IV, and V.

The conservancy district, to be formed under state law, will be responsible for securing land, easements, and rights-of-way, and to administer the contracts for the installation of works of improvement. The conservancy district will have the power of eminent domain and taxation as provided by the Indiana Conservancy Act. The conservancy district will also be responsible for providing that portion of the construction cost to be provided from other funds.

As sponsor, the Vigo County Soil and Water Conservation District will provide such assistance and guidance as necessary to expedite coordination between the land treatment and structural features of this plan.

Engineering services, in the form of surveys, investigations, construction plans and specifications, and construction inspection will be provided by the Soil Conservation Service.

The Indiana Flood Control and Water Resources Commission, in accordance with state laws and regulations, will review for approval the plans and specifications for the works of improvement to be constructed. These laws and regulations are embodied in the Conservancy District Law.

FINANCING PROJECT INSTALLATIONS

Federal assistance for carrying out the works of improvement on non-Federal land, as described in this work plan, will be provided under the authority of the Watershed Protection and Flood Prevention Act (P.L. 566, 83rd Congress, 68 Stat. 666).

Local assistance in carrying out the works of improvement will be handled by a conservancy district as provided by the Conservancy Act of Indiana of 1957. The Vigo County Soil and Water Conservation District, as the local sponsoring organization of the project, will assist in the formation and organization of the conservancy district.

The conservancy district, when organized, will, by provisions of the law and the purposes set forth in organization of the district, secure the land easements and rights-of-way necessary for the installation of the works of improvement. The right of eminent domain, provided by state law, may be used when necessary to secure land for the installation of the works of improvement. In addition, the conservancy district will administer the contracts for the construction of the works of improvement, provide the money representing the local share of costs for structural measures and carry out the responsibilities of the local people.

The "other than P.L. 566" share of the installation cost of structural measures is estimated to be $77,230, as shown in Table 1, and will be financed by the conservancy district. This figure includes $5,500 for the local share of the structural measure construction costs allocated to drainage, the cost of all necessary land, easements, and rights-of-way, which cost is estimated at $68,580, and the cost of the administration of contracts, estimated at $3,150.

The conservancy district will finance the local cost by a loan to

be secured from the Farmers Home Administration. A letter of intent has been filed by the sponsoring local organization with the State Director of F.H.A. to establish a line of credit for that agency to finance local costs after the conservancy district is formed.

PROVISION FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land owners will be responsible for the operation and maintenance of the land treatment measures on their lands. This work will be accomplished through cooperator agreements with the Vigo County Soil and Water Conservation District. Technical assistance for operation and maintenance will be provided by the Soil Conservation Service and the Division of Forestry, Indiana Department of Conservation im cooperation with the U. S. Forest Service under the Cooperative Management Program.

Structural Measures

The three floodwater retarding structures and the 4.9 miles of channel to be constructed will be operated and maintained by the proposed conservancy district. The conservancy district will maintain the channel and flood plain below the constructed channel in such a manner that it will not obstruct the flow of the constructed channel. The channel between floodwater retarding structure No. 1 and the upper end of the constructed channel will be maintained in approximately its present condition. The cost of operation and maintenance work is estimated to be $502 annually for the floodwater retarding structures and $3826 annually for the channels. This amounts to an annual total of $4,328.

Inspections of the structural measures will be made annually and as needed after severe storms. The team making these inspections will

consist of, at least, a representative of the conservancy district and a representative of the Soil Conservation Service. A record of the inspection will be kept in the file of the conservancy district and will be available for authorized inspections.

Land owners on whose land the structural works are located will enter into agreements with the conservancy district for maintenance. These agreements will specify the maintenance land owners are to perform, such as (1) reseeding and fertilizing of embankments and channel banks, (2) isolated channel spraying or mowing, and (3) removal of minor debris blocks in the channels and at the entrance to spillways. It is estimated that this work will amount to about 25% of the total operation and maintenance cost.

Other operations and maintenance work requiring special equipment, or otherwise beyond the capacity of the land owner, will be carried out by the proposed conservancy district by force account or contract. This work includes such items as: (1) repairing of major damage to structure embankments and to spillways, (2) major streambank spraying, and (3) major repair or cleamout of stream channel bottom and banks. The conservancy district, now in the process of formation, will acquire, by taxation, the funds for operation and maintenance.

Specific operation and maintenance agreements will be executed between the conservancy district and the Soil Conservation Service prior to the issuance of invitations to bid on construction.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Prairie Creek Watershed, Indiana

Installation Cost Item	No. to be Applied			Estimated Cost (Dollars) 1/				
				P. L. 566		Other		Total
	Unit	Non-Fed Land	Total	Non-Fed Land	Total	Non-Fed. Land	Total	
LAND TREATMENT FOR WATERSHED PROTECTION								
Soil Conservation Service								
Cropland	Acres	13,260	13,260			118,800	118,800	118,800
Grassland	Acres	2,440	2,440			19,810	19,810	19,810
Idle & Miscellaneous	Acres	350	350			680	680	680
Technical Assistance				34,750	34,750	6,340	6,340	41,090
SCS Subtotal				34,750	34,750	145,630	145,630	180,380
Forest Service								
Woodland	Acres	1,800				6,380	6,380	6,380
Technical Assistance				1,650	1,650	1,980	1,980	3,630
FS Subtotal				1,650	1,650	8,360	8,360	10,010
TOTAL LAND TREATMENT				36,400	36,400	153,990	153,990	190,390

1/ Price Base 1962

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TABLE 1 - ESTIMATED PROJECT INSTALLATION COST
Prairie Creek Watershed, Indiana

Installation Cost Item	No. to be Applied			Estimated Cost (Dollars) 1/				
				P. L. 566		Other		
	Unit	Non-Fed Land	Total	Non-Fed Land	Total	Non-Fed. Land	Total	Total
STRUCTURAL MEASURES								
Construction Cost								
Soil Conservation Service								
F.W.R. Structures	No.	3		163,600	163,600			163,600
Channel Improvement								
Multi-Purpose F.P. & Dr.	Miles	1.3		22,300	22,300	5,500	5,500	27,800
Single Purpose F.P.	Miles	3.6		116,100	116,100			116,100
Subtotal Construction				302,000	302,000	5,500	5,500	307,500
Installation Services								
Soil Conservation Service								
Engineering Service				92,300	92,300			92,300
Other				24,500	24,500			24,500
Subtotal Inst. Services				116,800	116,800			116,800
Other Costs								
Land Easements & R/W						68,580	68,580	68,580
Adm. of Contracts						3,150	3,150	3,150
Subtotal Other Costs						71,730	71,730	71,730
TOTAL STRUCTURAL MEASURES				418,800	418,800	77,230	77,230	496,030
TOTAL PROJECT				455,200	455,200	231,220	231,220	686,420
SUMMARY								
Subtotal SCS				453,550	453,550	222,860	222,860	676,410
Subtotal FS				1,650	1,650	8,360	8,360	10,010
TOTAL PROJECT				455,200	455,200	231,220	231,220	686,420

1/ Price Base 1962

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TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(At Time of Work Plan Preparation)
Prairie Creek Watershed, Indiana

Measures	Unit	Applied To Date	Total Cost (Dollars)
Land Treatment			
Conservation Cropping System	Acre	2,400	2,400
Grass Waterways	Acre	360	66,600
Diversions	Feet	45,000	4,950
Grade Stabilization Strs.	Number	5	1,500
Tile	Feet	200,000	56,000
Open Drain	Feet	20,000	9,000
Pasture Planting	Acre	100	4,000
Forestation	Acre	50	1,750
Livestock Exclusion	Acre	50	200
Total			146,400

Price Base 1962 September 1963

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION
Prairie Creek Watershed, Indiana

(Dollars) 1/

Measure	Structure Number	Installation Cost - P.L. 566 Funds				Installation Cost - Other Funds				Total Other	Total Inst. Cost
		Construction	Install. Engrg.	Services Other	Total P.L. 566	Construct.	Inst. Serv.	Other Adm. of Contr.	Other L.E. & R/W		
FWR Struc.	1	68,700	20,600	5,500	94,800			700	26,300	27,000	121,800
	2	55,900	16,800	4,500	77,200			560	8,170	8,730	85,930
	3	39,000	11,700	3,100	53,800			390	3,010	3,400	57,200
Subtotal FWR Strucs.		163,600	49,100	13,100	225,800			1,650	37,480	39,130	264,930
Channel Improvement Multi-Purpose Flood Preven. & Dr.											
	Reach V	22,300	8,400	2,100	32,800	5,500		300	3,600	9,400	42,200
Single Purpose Flood Prevention											
	Reach IV	50,600	15,200	4,000	69,800			500	15,200	15,700	85,500
	Reach III	45,700	13,700	3,700	63,100			500	10,800	11,300	74,400
	Reach II	19,800	5,900	1,600	27,300			200	1,500	1,700	29,000
Subtotal Channel Impr.		138,400	43,200	11,400	193,000			1,500	31,100	38,100	231,100
GRAND TOTAL		302,000	92,300	24,500	418,800	5,500		3,150	68,580	77,230	496,030

1/ Price Base 1962

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TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY
Prairie Creek Watershed, Indiana

(Dollars) 1/

Item	Purpose		
	Flood Prevention	Drainage	Total
Single Purpose			
F.W.R. Structures	264,930		264,930
F.P. Channel	188,900		188,900
Multi-Purpose			
Reach V - F.P. and Agr. Wat. Mgmt.(Drainage)	25,490	16,710	42,200
TOTAL	479,320	16,710	496,030
P.L. 566	409,140	9,660	418,800
Other	70,180	7,050	77,230
TOTAL	479,320	16,710	496,030

1/ Price Base 1962 September 1963

TABLE 3 - STRUCTURE DATA
Floodwater Retarding Structures
Prairie Creek Watershed, Indiana

Item	Unit	Structure Number 1	2	3	Total
Drainage Area	Sq.Mi.	9.76	3.73	1.61	15.10
Storage Capacity					
Sediment	Ac.Ft.	395	165	75	635
Floodwater	Ac.Ft.	1338	511	214	2063
Total	Ac.Ft.	1733	676	289	2698
Betw.High & Low Stage	Ac.Ft.	521	200	91	812
Surface Area					
Sediment Pool	Acres	72	34	15	121
Flood Pool	Acres	260	89	40	389
Volume of Fill	Cu.Yd.	49,000	42,200	29,000	120,200
Elev. Top of Dam	Ft.	531	521	519	-
Max. Height of Dam	Ft.	27	23	25	-
Emergency Spillway					
Crest Elevation	Ft.	525.5	517.5	516.5	
Bottom Width	Ft.	200	120	80	
Type		Veg.	Veg.	Veg.	
Percent Chance of Use		2	2	2	
Ave.Curve No.-Cond. II		80	80	78	
Emerg. Spwy Hydrograph					
Storm Rainf.(6 hr.)	Inches	4.55	4.55	4.55	
Storm Runoff	Inches	2.51	2.51	2.34	
Vel. of Flow (Vc)1/	Ft/Sec.	0	0	0	
Discharge Rate 1/	c.f.s.	0	0	0	
Max. W/S Elev. 1/	Ft.	525.3	516.9	516.2	
Freeboard Hydrograph					
Storm Rainf.(6 hr.)	Inches	13.73	9.84	8.29	
Storm Runoff	Inches	11.14	7.37	5.66	
Vel. of Flow (Vc)1/	Ft/Sec.	9.7	7.8	6.5	
Discharge Rate	c.f.s.	5720	1780	740	
Max. W/S Elev. 1/	Ft.	530.8	520.8	518.9	
Principal Spillway					
Capac.-Low Stage	c.f.s.	98	37	16	
Capac.-High Stage	c.f.s.	255	97	61	
Storm Rainfall	Inches	4.15	4.15	4.15	
Storm Duration	Hours	6	6	6	
Runoff Curve No.		87	87	86	
Storm Runoff	Inches	2.78	2.78	2.68	
Capacity Equivalents					
Sediment Volume	Inches	.76	.85	.88	
Detention Volume	Inches	2.57	2.57	2.49	
Spillway Storage	Inches	4.14	2.11	1.28	
Class of Structure		a	a	a	

1/ Maximum during passage of hydrograph

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TABLE 3A - STRUCTURE DATA
CHANNELS
Prairie Creek Watershed, Indiana

Channel Designation	Sta. No. for Reach Sta. (100 Ft.)	to Sta. (100 Ft)	Watershed Area 1/ Sq.Mi.	Purpose 2/	Required Channel Capacity c.f.s.	"n"	Grade Pct.	Bottom Width Feet	Side Slope	Ave. Depth Feet	Average Channel Area Sq.Ft.	Average Velocity Ft/Sec.	Volume of Excavation 1000 CuYd
Reach II	228	333	27.93	F.P.	1560 3/	.035	.13	35	2:1	6.7	324	4.81	25
Reach III	270	288	24.10	F.P.	1240	.035	.13	35	2:1	6.5	312	3.98	
	262	270	22.56	F.P.	1060	.035	.13	30	2:1	6.2	263	4.03	98
	225	262	22.17	F.P.	1000	.035	.13	30	2:1	6.0	252	3.97	
Reach IV	208	225	19.61	F.P.	900	.035	.13	30	2:1	5.8	241	3.73	
	199	208	19.61	F.P.	900	.035	.08	30	2:1	5.8	241	3.73	
	191	199	19.09	F.P.	845	.035	.08	30	2:1	6.0	250	3.38	107
	173	191	18.66	F.P.	800	.035	.08	30	2:1	6.0	250	3.20	
	161	173	17.91	F.P.	700	.035	.08	20	2:1	6.2	201	3.48	
	143	161	17.55	F.P.	650	.035	.08	20	2:1	6.3	206	3.15	
Reach V	125	143	13.15	M.P.	580	.035	.08	16	2:1	6.4	184	3.15	
	113	125	11.56	M.P.	370	.035	.15	8	2:1	6.1	123	3.00	41
	100	113	11.25	M.P.	320	.035	.15	6	2:1	5.6	96	3.34	
	75	100	10.82	M.P.	270	.035	.15	6	2:1	5.1	82	3.29	

1/ Watershed area includes the controlled area

2/ Flood Prevention - F.P.
Multiple Purpose - M.P.

3/ This capacity is above bank full

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TABLE 4 - ANNUAL COST
Prairie Creek Watershed, Indiana

(Dollars) 1/

Evaluation Unit	Ammortization of Installation Cost 2/	O & M Cost 3/	Total
1. Floodwat. Ret. Strs. 1, 2, 3 and Chan. Imp. Reach II, III, IV, V	19,280	4,328	23,608
TOTAL	19,280	4,328	23,608

1/ Price Base 1962 for Installation Cost - Projected Long Term Cost for O & M.

2/ Amortized at 3% for 50 years.

3/ Includes O & M to maintain present capacity in reaches where no construction is planned.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS
Prairie Creek Watershed, Indiana

(Dollars) 1/

Item	Estimated Average Annual Damage		Damage Reduction Benefit
	Without Project	With Project	
Floodwater			
Crop and Pasture	14,082	3,472	10,610
Other Agricultural	821	214	607
Non-Agricultural			
Road and Bridge	7,030	530	6,500
Subtotal	21,933	4,216	17,717
Erosion (Flood Plain Scour)	1,066	534	532
Indirect	2,300	474	1,826
TOTAL	25,299	5,224	20,075

1/ 1962 Price base - projected long term prices

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Prairie Creek Watershed, Indiana

(Dollars) 1/

Evaluation Unit	Measure	AVERAGE ANNUAL BENEFITS						Average Annual Cost	Benefit Cost Ratio
		Flood Prevention			Drainage	Secondary	Total		
		Damage Reduction	More Intens. Use	Changed Land Use					
1.	FWR Structs. 1, 2, 3 and Channel Improvement Reach II, III, IV, V	19,470 2/	6,576	1,675	6,726		34,447	23,608	1.5-1
		19,470 2/	6,576	1,675	6,726	5,120	39,567	23,608	1.7-1 3/

1/ Base price 1962 for installation costs - Projected long term for benefits and O & M costs.

2/ In addition, Land treatment Measures will provide flood reduction benefits of $605.

3/ Benefit-Cost Ratio including secondary benefits.

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INVESTIGATIONS AND ANALYSES

Project Formulation

This plan was conceived and formulated for the express purpose of reducing flood damages on the flood plains of this watershed. The Vigo County Soil and Water Conservation District has been operating for 13 years for the purpose of reducing water runoff, soil loss and improving agricultural water management. Land treatment measures alone, it was soon recognized, did not bring about the desired reduction of flood plain damages. Most of the benefits were on-site in nature. However, for some time, local interests have considered additional controls, such as floodwater retarding structures and channel improvements. The possibilities under P.L. 566 are best suited to the realization of these goals. Numerous combinations of possible measures were considered in selecting a feasible, integrated project capable of realizing the desired protection.

Land Use and Land Treatment

A determination of the land treatment needs and land use conversions required was one of the first steps in formulation of the overall project. Land capability units and the proportions of land use categories in the watershed provided acreage figures for these groupings. Some of this data was obtained from the Vigo County Conservation Needs Inventory, adjusted to the problem areas within the watershed. Combinations of land treatment measures and the necessary land use conversions applicable to each land capability unit were determined and summarized.

The cost for technical assistance and for the installation of these measures was then determined. A summary of these various costs is shown in Table 1.

Hydrologic and Hydraulic Investigations

Hydrologic and hydraulic investigations conducted for the watershed were used in developing physical data for the economic evaluation and the design of proposed works of improvement.

There being no active U. S. Geological Survey stream gaging stations available in the watershed, rainfall data were used for project evaluation. The U. S. Weather Bureau Technical Paper No. 40, "Rainfall Frequency Atlas of the United States," was chosen as the source of rainfall frequency. The data from the rain gage, located at Terre Haute, Indiana, approximately fifteen miles northeast of this watershed, has been integrated into the T.P.-40 frequency studies by the U. S. Weather Bureau.

Soil Cover Complex Curve Numbers reflecting present conditions for individual structures and the entire watershed were developed by field investigations and the use of data furnished by the Work Unit Conservationist, Soil Scientist, and Geologist. Soil Cover Complex numbers for future conditions were developed by assuming the land treatment measures installed during the installation period of the project. The average runoff curve number for present watershed conditions was calculated as 77 and for future condition as 76.

The design runoff curve number for each structure was developed by evaluation of the watershed conditions above each site. These curve numbers are deemed accurate enough for final design. Runoff for the design frequency of the principal spillway was obtained from either the 6-hour duration rainfall values in T.P.-40 using antecedent moisture conditions II$\frac{1}{2}$, or by the method set forth in SCS, T.R.-10 using antecedent moisture condition II. Release rates and draw down time were checked by T.R.-10 for each structure.

The emergency spillway and freeboard design were based upon Soil Conservation Service criteria. The criteria, as established by Engineering Memorandum--Indiana 7, dated January 9, 1963, was adhered to for all hydrologic criteria. The spillway design data, along with other structural information, are shown in Table 3.

The main channel of Prairie Creek, from Vigo, Indiana, to the headwater areas, was divided into six evaluation reaches based on hydraulic, economic, and physical characteristics. Eight full valley and eight channel cross sections were surveyed to mean sea level datum. Stage-discharge curves were prepared for each full valley cross-section using Manning's formula. The storage-indication flood routing procedure was used in routing the 50, 10, and 3 year frequency floods through the main stream under present and future conditions with the proposed works of improvement of the project assumed to be in place. A routing of land treatment and structures 1, 2, and 3 failed to provide the desired level of protection. It was finally determined by routings that a combination of land treatment, structures 1, 2, and 3, and channel improvement in Reaches V, IV, III, and II would give the five year desired level of protection to the agricultural flood plain. A six hour duration storm was used for damage appraisal.

Triangular hydrographs were developed based on time of concentration using the method set forth in E & WP Hydrology Memo #4 for obtaining the peaks. These hydrographs were routed and accumulated down the main channel through the routing reaches.

The peak discharges were determined at the foot of each routing reach by the storage-indication method of routing. The peak rates of discharge at intermediate cross-sections within the routing reaches were

interpolated by a logartithmic relationship between drainage area and the rate of discharge, using the concordant flow principle.

Stage-area inundated curves were developed for each selected reach. Stage-area inundated tables, 0-2 feet depth and over 2 feet depth, were prepared for each evaluation reach. This information was then coordinated with stage-discharge and discharge-frequency curves.

Recurrent flooding during the growing season and the effect of backwater from the Wabash River have been considered and included in the hydrologic and hydraulic conditions. It was determined for this project evaluation that the growing season shall begin in April and terminate in November. During the growing season it was determined, by using T.P. #40, that the seasonal probability of a six hour duration rainfall expected on a one year frequency basis is about ninety percent of that anticipated during the calendar year. Therefore, ninety percent of the yearly rainfall was used to compute the growing season rainfall used in project evaluation.

Engineering Studies, Design, and Cost Estimates

Due to the limited number of good structure sites the waterflow control studies were limited to the proposed project and alternatives of this project. The channel improvement was considered supplementary to the retarding structures. Alternate sites were considered for each of the three proposed floodwater retarding structures. Two additional floodwater retarding structures were evaluated. These structures were not included because they did not bring about any substantial increase in benefits or reduction in channel cost. The proposed works of improvement, as set forth in this plan, were determined to be the most practical to achieve the objectives of the local organization.

The basic data used in structure evaluation and design was obtained from U. S. Geological Survey topographic maps, aerial photographs, field surveys, and field observations.

The storage and area flooded versus stage curves were developed from the topographic maps. Field surveys were made along the centerline of the fill of each proposed structure. A cross section of the reservoir area was taken on structure numbers 1 and 2. These field surveys were used to check the surface area and storage curves obtained from the topographic maps. A topographic map of the emergency spillway area of structure No. 1 was made from a field survey. This map was used to determine the yardage of excavation from the emergency spillway. The centerline of the fill sections were used in the computation of embankment yardages. Elevations of critical points such as roads, buildings and the cemetery above structure No. 2 were determined from field surveys. All of the field surveys were based on sea level datum.

The structures are designed to meet the criteria contained in Engineering Memorandum--Indiana 7, SCS-Engineering Memorandum No. 27, other applicable SCS Engineering Memorandum, and the minimum design standards of the Indiana Flood Control and Water Resources Commission.

The requirements for sediment storage, as given by the Geologist, were used to set the elevation of the low stage inlet. The aerated portion of the sediment yield was deducted from the available storage between the low stage and the emergency spillway.

The crest elevation of the emergency spillway for each structure was set by flood routing a 50 year frequency storm of six hour duration, using antecedent moisture condition II$\frac{1}{2}$. A check of the storage requirements was made on structure No. 1 using the procedure given in Technical

Release No. 10. This T. R. 10 check was made using a 25 year frequency storm and antecedent moisture condition II. The storage indicated by this procedure was considerably less than that required by the routed storm. Since the release rates (cubic feet per second per square mile of drainage area) of structure numbers 2 and 3 were higher, a T.R. 10 check was not made on these structures. The inflow hydrographs were developed by the C.T.U. method given in Section 3.21 of the Hydrology Guide. The low stage release rates and the low stage storage were determined by the downstream channel capacities and the desired level of protection. The conduit size was that which gave the most economical design.

The dimensions of the emergency spillway and the elevation of the top of the dam were based on the flood routing of the freeboard hydrograph and the economics of the site. Considered in the economics of the site were the amount and cost of fill in the dam, the amount of excavation from the emergency spillway, the cost of the land, easements and rights-of-way, and the cost of the principal spillway. The capacity of the emergency spillway was determined by the procedures set forth in Technical Release No. 2 and Supplement A to T.R. No. 2.

The embankment and foundation design was based on the geological report. The saturated sands under the dams present the problems of foundation strength and permeability. Relief wells were included in the cost estimates for each structure to release pore pressures and provide an outlet for water movement under the dam.

The channel design and estimates were based on field surveys, existing profiles, U. S. Geological Survey topographic maps, aerial photographs, and field observations. The full valley and channel cross sections used by the Hydrologist were used to determine the bank full elevation

and the grades of the designed channel. An existing profile, made for a preliminary report of a group drainage enterprise, was used to determine the elevation of the bridges and the rock profile in Reaches I and II. The topographic maps and aerial surveys were used to determine the location of the channel. Hand auger borings were made to determine the materials into which the channel will be cut.

The channel is designed to carry a five year frequency growing season storm. Water surface profiles were computed through the designed channel. The present condition rating curve for valley section 3 (Sta. 323+00) was used to determine the starting elevation for the water surface profile computations. The outlet of the proposed channel is in the existing channel on rock bottom. A ridge in the channel bottom exists near Station 326+00 due to the sandstone bedrock. It is planned to continue the design grade of the channel downstream to remove the high point of rock. This excavation will be in the bottom of the existing channel only and will involve moving about 350 cubic yards of rock. The maximum velocity of the planned channel is approximately $5\frac{1}{2}$ feet per second near the outlet where the water surface is drawn down due to the water being allowed to spread over the flood plain.

The constructed channel will be located near the existing channel but will be straightened. The bank, berm, and inside of the spoil will be seeded to reduce the cost of maintenance and help stabilize the channel. The channel is so designed that the bottom grade will be above the saturated sand which is under most of the flood plain.

The valley and channel sections were used to determine the quantities of excavation considering the location of the planned channel as compared to the present channel. The quantities of clearing were

determined by aerial photographs. The location and number of appurtenances were determined from the topographic maps and aerial photographs. The types of appurtenances were not determined; some of them will probably be corrugated metal pipes with hooded inlets, toewalls with a sod chute or channel above, and some will be lateral channels graded to the new channel bottom.

Geological, Sedimentation and Erosion Investigations

Preliminary geologic site investigations were carried out at the three proposed floodwater retarding structure sites. The information revealed in the investigations was reported on form SCS-375, copies of which were provided to the Planning Engineer and the Engineering and Watershed Planning Unit Geologist.

Investigations were made with a soil auger and probe. Local physiographic characteristics were studied and overburden profiles were examined where exposed. The overburden consists of heterogeneous layers and lenses of glacial deposits of silts sands and gravels. Additional information regarding these sites and the general area was obtained through discussions with specialists on glacial deposits at the Indiana Department of Conservation, Geological Survey Division.

There appear to be no problems in foundation stability at any of the sites. The likelihood of permeable layers under the fill has been considered and adequate costs for remedial measures have been included. Adequate, suitable borrow is available at each site.

Detailed site investigations are recommended for each site preparatory to design. The estimated costs of these proposed investigations is noted on the appropriate form, SCS-375 and are included in the Installation Services Cost for each structure as shown in Table 2.

All types of erosion were studied in the drainage areas above proposed floodwater retarding structures. This was done to determine the amounts and character of sediment which will affect the design and maintenance of the structural works of improvement.

Sediment storage design data were provided to the Planning Engineer for each of the three sites and is considered adequate for final design.

Field studies were made to determine the extent of flood plain land damage due to erosion. Flood plain scour is the only significant damage of this nature in the watershed. Surveyed and plotted cross sections, prepared for hydrologic and economic evaluations, were used for this study. These cross sections were augmented by additional ranges to the extent that there were at least three for each reach. Soil borings were made along these cross sections or ranges and at the same time a careful study of field conditions was included. These studies included observation of the bases of trees, fence posts and other such features to determine any change in flood plain level. In three reaches a width of flood plain adjacent to the channel showed evidence of frequent scour damage.

The data gathered in this manner on each cross section or range was expanded for the damage reach and summarized to show location, extent of damage and stage at which the damage occured. The resulting data form the basis for economic evaluations. Scour damage amounts to an estimated weighted average of 19% on 6.4 acres annually.

Damage to flood plain roads, road ditches and culverts was obtained by interview relating to specific sites and is supported by documents from county highway officials. This damage was obtained as dollar damage for annual, moderate and extreme storms. The figures, although regarded as conservative, indicate that road damage is very costly in this

watershed. The data was provided to the Economist for evaluation purposes.

Sheet erosion, as well as other types of erosion, was appraised by the Vigo County Work Unit Conservationist and the supervisors of the Vigo County Soil and Water Conservation District. Present and future land use trends, installed and proposed conservation measures and present and improved farm management levels were considered in assembling data to determine present and future erosion conditions. Available soil survey data were basic factors in preparing the erosion estimates. Applying Indiana slope and practice data procedures, gross sheet erosion was determined. Sediment delivery ratios from source to site were estimated in consideration of such factors as drainage characteristics, source to site distances and size of drainage areas involved. SCS-309 forms were prepared for each site in accordance with T.R.#12 and copies were provided to the Planning Engineer.

Sediment damage studies were made in the field in the same manner as described for erosion investigations. Minor amounts of infertile, sandy overwash were found in the upper reaches adjacent to channels, but this damage was considered insufficient to warrant evaluation.

Channel filling occurs in Reach V, but as described elsewhere in this plan, it is considered inseparable from flooding and impaired drainage damages. While the floodwater retarding structures will reduce the amount of sediment to fill channels in future conditions, it is possible the channel improvement in Reach V will have even more effect. It is apparent that the complete project will greatly reduce the combined flooding and impaired drainage problems. Channel cleanout in this reach has not been attempted in recent years.

Economic Investigations

The basic information for agricultural type damages was obtained from personal interviews and questionnaires circulated to all the farmers within the flood plain. Approximately 95% of the farmers and farm operators were contacted to obtain information on crop production, crop damage and land use with the aid and cooperation of the local sponsoring organization. Non-agricultural damages were obtained from highway and public utilities officials, and others connected with maintenance of these facilities.

All cost and prices used were based on 1962 price level. All damages, benefits, and operation and maintenance costs were converted to long term prices using "Agricultural Price and Cost Projections," September, 1957, published by the U. S. Department of Agriculture. Farm operation costs were based on custom rates charged for power operated farm machinery, and other costs; such as seed, fertilizer and labor, obtained locally and converted to projected long-term prices.

A 3% interest rate was used in converting public and private investment eligible for Federal loans and a 5% rate in converting associated costs to annual basis. Evaluation of all project benefits were based on a 50 year period.

Land easement and rights-of-way cost estimates were arrived at by (1) measuring the area involved by each floodwater retarding structure as plotted on topographic maps; (2) estimating the area needed for channel improvement; (3) determining the per acre cost of the land involved as estimated by the local sponsors in consultation with the Service. These values were checked against the average net production per acre for this land under present conditions and use. There was little or no difference

between this and the amortized acre cost that is included in the installation cost as land easements and rights-of-way.

Floodwater damages and benefits were computed using the frequency method as described in Chapter 3 of the Economic Guide, Soil Conservation Service. Separate damage frequency curves were developed for each reach and each type of damage using the stage frequency data provided in the hydrologic study.

The procedure used for intensive study of crop and pasture damage is based upon the damage resulting from the largest flood in each year, with a 20% adjustment factor to convert to the most damaging flood each year.

Full valley cross-sections which were combined into damage reaches (also hydrologic reaches) were used in determining the acres flooded by depth increments of 0-2 and over 2 feet. Due to impaired drainage in Reach V, a separate composite acre value was used for this reach. There were no changes in land use of flood plain acres having a major change in elevation.

Flood damage factors for each month and for two depth categories, 0-2 and over 2 feet, were determined for each crop. Damage schedules were developed, by months, for the different crops and weighted by the percent of monthly rainfall districution. An average annual damage figure per acre for the two depth categories was computed for each composite acre.

The composite acre and flood free yields used are as follows:

REACH - I, II, III, IV, VI

Without Project	Crop	Yield/Acre	Percent
	Corn	80 bu.	50.0
	Soybeans	25 bu.	21.5
	Wheat	30 bu.	2.5
	Meadow	3 ton	3.5
	Perm. Pasture	75 C.P.D.	7.0
	Other	-	15.5
	REACH V		
	Corn	60 bu.	52.5
	Soybeans	20 bu.	22.5
	Woods	-	15.5
	Other	-	9.5

The average annual damage figure per acre, based on the two above composite acres for depth 0-2 feet and over 2 feet, was used to develop a stage damage curve for each reach. From peak discharge-frequency relationship, a flood damage versus frequency of occurrence graph was made. The average annual crop and pasture damage for each reach was then determined by planimetering the area under the curve and converting to dollar damage according to the scale of the graph.

The average annual benefit, by reaches, due to works of improvement, was determined by subtracting the remaining damages with the works of improvement from the damage evaluated without the measures.

Other agricultural damages were based on damage value per acre as determined from interview information. The amount of money spent for the removal of debris and fence repair was related to the area flooded for three frequency size floods; large (25 to 50 year flood); medium

(10-15 year flood); and small (annual or two-year flood). The area flooded by each of these floods was available from crop and pasture damage studies for each reach.

The average annual damage and benefit for each reach was determined from its respective damage versus frequency curve as explained above for crop and pasture.

Non-agricultural damages, as shown in this report, are mainly to roads and bridges. Information was obtained from highway officials and maintenance crews as to the amount of damage at different depths and sizes of flood. Using information from the Hydrologist, these occurrences were grouped as to frequency. The monetary value of damages due to a large flood--25 to 50 year, medium size flood--10 to 15 year and the stage at which damage begins was obtained for each significant damage location in a reach. A damage versus frequency curve was developed. The stage and frequency at which no flood damage occurs and the frequency and stage of the medium and large size floods was determined by the Hydrologist based on cross-sectional data at or near the point of damage.

The monetary value of the average annual damage to roads and bridges was obtained by use of the damage versus frequency curve for with and without the proposed works of improvement. Average annual benefit was derived by subtracting the remaining damages from the damage evaluated without the measure.

Estimates of erosion damage in the way of flood plain scour were developed by, (1) composite acre value of land being damaged, (2) annual increment of damage, (3) percent reduction in productivity, and (4) expected recovery. The formula used for converting to monetary terms is outlined in the Engineering and Watershed Planning Unit October 1954 Training

Outline, Flood Plain Scour, III-A-2-c-(4), page 118. The reduction of damage was computed as a 100% reduction on that part of the flood plain no longer flooding after installation of project.

Indirect damages were estimated to be ten percent of the total agricultural and non-agricultural damage.

Agricultural Water Management: Drainage

An area of 255 acres outside the flood plain depends in part upon the main channel for drainage outlet. Drainage benefits were computed through increased yields less the increased production costs on existing cropland. These benefits are made possible by drainage measures designed to remove excess water from 127 acres of land on which, under present conditions, a high water table limits agricultural production. The needed on-farm drainage appears reasonable to achieve and is in agreement with the sponsoring local organization that these measures will be installed to meet the needs for drainage in this area.

Joint benefits to the multiple purpose channel in Reach V were computed on the total bottomland that depends upon the channel for tile outlets and is affected by flooding. Benefits were estimated on the basis of 85% participation in accomplishing the land improvements and allowing a ten year lag in accrual on 40% of the area.

More Intensive Use benefits on 320 acres in Reach V and the conversion of 90 acres of woodland to cropland was based on landowner's estimate. These benefits are joint benefits to flood reduction and drainage measures.

Cost Allocation and Cost Sharing - Drainage

The cost of the multiple purpose channel in Reach V, designed for flood prevention and drainage, was allocated by the second alternative

method as described in the Watershed Protection Handbook, paragraph 1132.212.

The following data and computations show the allocation procedure and costs assigned to each purpose:

A.	Installation Cost of Multi-purpose Channel	$42,200
B.	Damage Reduction Benefits	5,784
C.	Joint Benefits (Land Enhancement)	8,982
D.	Drainage Benefits (Outside Flood Plain)	2,235

F.P. Benefit	Joint	Drainage	Total Benefits
$5,784	$8,982	$2,235	$17,001
4,491		4,491	
$10,275		$6,726	$17,001
60.4%		39.6%	100.0%

Flood Prevention	60.4%	$42,200	$25,490 F.P. Cost
Drainage	39.6%		16,710 Dr. Cost

Cost sharing of drainage cost is based on a 50-50 share of the construction cost. This is in accordance with the policy of the Secretary dated 10-9-62.

Data on cost sharing is as follows, based on allocated cost to drainage:

	P.L. 566	Other	Total
Construction Cost	$22,300	$5,500	$27,800
Installation Services	10,500	-	10,500
Land Easement & R.O.W.	-	3,600	3,600
Adm. of Contract	-	300	300
Total	32,800	9,400	42,200

Determination of Annual Benefits from More Intensive Use of Present Cropland

Benefits due to more intensive use of present cropland within the flood plain were determined from basic field data obtained from farmer interviews and professional agricultural leaders. This information was used to determine the level of production expected with adequate internal drainage, a stable water table and a moderately high level of fertility and management program that could be expected with the level of protection proposed by this project.

In determining the number of acres that will be farmed at a more intensive use due to reduced flooding, a tabular form was used showing the number of acres flooded at average of 2-year and 5-year frequencies for "without project" and "with project" conditions. This represents the range (3 to 5 year) protection generally required to bring about fertility practices and management that will result in added income from more intensive use of present cropland. The proposed measures will reduce the frequency of flooding on 435 acres on which a more intensive use benefit will be derived.

All production type benefits were determined by (1) the expected participation, (2) future net income, (3) deducting all associated costs, (4) discounting for lag in accrual, and (5) deducting future flood damage to a higher damageable crop.

Evaluation of Secondary Benefits

Secondary benefits were evaluated on the following basis: (1) value of local secondary benefits stemming from the project were considered to equal 10% of direct primary benefits less indirect benefits, (2) secondary benefits induced by the project were considered to equal 10% of the increased cost in connection with increased production.

Reach V - Supporting Data - Changed Land Use (Joint)

110 Acres Woodland, 85% Participation - 90 Acres

Land Use	Acres	Flood Free Yield	Gross Value (Dollars)	Production Cost (Dollars)	Net Return (Dollars)
Corn	52	100 bu.	7,228	2,630	4,598
Soybeans	24	30 bu.	1,656	579	1,077
Wheat	3	35 bu.	163	84	79
Meadow	6	4 tons	456	260	196
Perm. Pasture	5	120 C.P.D.	96	21	75
	90				6,025
Less associated costs - Clearing $175 x 90 x .05478					863
Tile & Open Dr. $13,176 x .05478					721
Less added flood damage to higher damageable values					215
Ave. annual changed land use (joint) benefit discounted @ 5% straight line for 10 years ($4,226 x .793)					$3,350

Reach V - Supporting Data - More Intensive Use (Joint)

Without Project Composite Acre Basis:

Land Use	Flood Free Yield	Gross Value of Product. (Dollars)	Production Cost (Dollars)	Net Return (Dollars)	Percent	Composite Acre (Dollars)
Corn	60 bu.	83.40	37.62	45.78	70.0	32.05
Soybeans	20 bu.	46.00	20.56	25.44	30.0	7.63
Total					100.0	39.68

Supporting Data - More Intensive Use of Flood Plain Land - Reach III, IV, and VI

Without Project Composite Acre Basis:

Land Use	Flood Free Yield	Gross Value of Product. (Dollars)	Production Cost (Dollars)	Net Return (Dollars)	Percent	Composite Acre (Dollars)
Corn	80 bu.	111.20	41.34	69.86	59.2	41.35
Soybeans	25 bu.	57.50	21.39	36.11	25.4	9.17
Wheat	30 bu.	46.50	23.95	22.55	3.0	.67
Meadow	3 ton	57.00	43.29	13.71	4.1	.56
Rot.Past.	100 C.P.D.	16.00	4.40	12.60	8.3	1.04
Total					100.0	52.79

With Project Composite Acre Basis: All Reaches

Land Use	Flood Free Yield	Gross Value of Product. (Dollars)	Production Cost (Dollars)	Net Return (Dollars)	Percent	Composite Acre (Dollars)
Corn	100 bu.	139.00	50.58	88.42	58.3	51.55
Soybeans	30 bu.	69.00	24.14	44.86	26.5	11.88
Wheat	35 bu.	54.25	27.83	26.42	3.8	1.00
Meadow	4 ton	76.00	56.62	19.38	6.0	1.06
Rot.Past.	120 C.P.D.	19.20	4.25	14.95	5.4	.81
Total					100.0	66.30

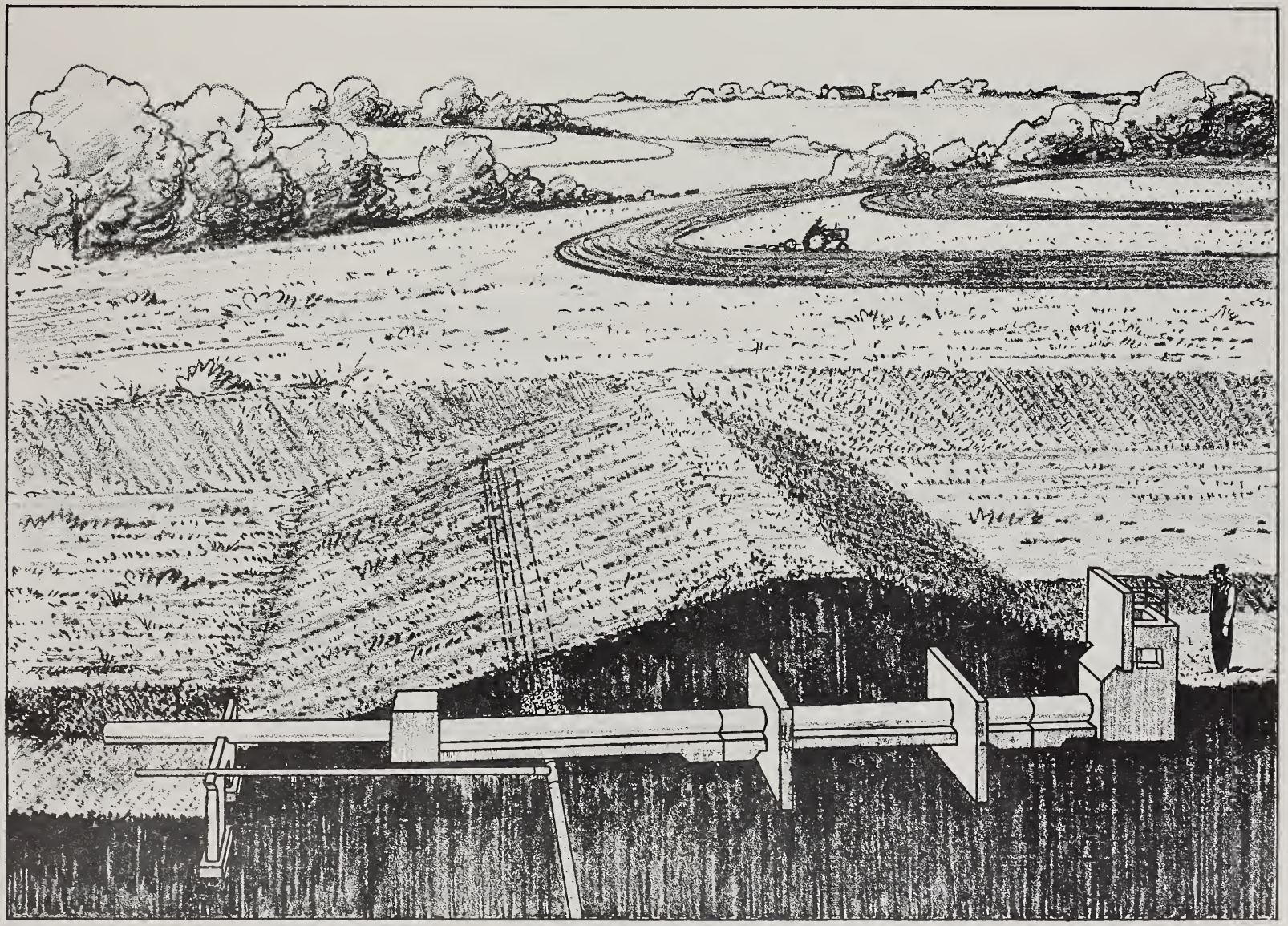
Reach III, IV, VI - More Intensive Use - Increased Net Return	13.51
Less associated Cost (Open & Tile Drainage)	1.68
Less added flood damage to higher damageable values	2.39
	9.44
60% within installation period - No discounting 60% x 9.44	5.66
40% within next 10 years - Straight line @ 5% 40% x 9.66 x 0.793	2.99
Total annual benefit/acre	8.65

435 acres x 8.65 = $3,760 More Intensive Use Benefit

Reach V (Joint & Drainage) Increase Net Return	26.62
Less associated cost (open & tile drain)	5.04
Less added flood damage to higher damageable values	2.39
	19.19
60% within installation period - No discounting 60% x 19.19	11.51
40% within next 10 years - Straight line @ 5%	
40% x $19.19 x 0.793	6.09
Total annual Benefit Per Acre	17.60

320 acres x 17.60 = $5,632 Joint Benefit

127 acres x 17.60 = $2,235 Drainage Benefit



Dry basin type earthfill dam with two-stage inlet.

FIGURE 1

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

PROJECT MAP
PRAIRIE CREEK WATERSHED
VIGO COUNTY, INDIANA

87°30' 87°27' 87°24'

39°21' 39°18' 39°15'

N

0+00 75+00 142+70 225+10 288+00 344+00 399+20

REACH I REACH II REACH III REACH IV REACH V REACH VI

D.A.-6314 acs.

D.A.-2417 acs.

D.A.-1047 acs.

Terre Haute Federal Penitentiary (Prison Farm)

4 LANE HIGHWAY

RAILWAY

ILLINOIS EASTERN CHICAGO

U.S. 41 & 150

Pimenta

Vigo

Prairie Creek

PRAIRIE CREEK

Prairie

IND. 63

IND. 246

VIGO COUNTY

SULLIVAN COUNTY

T 11 N
T 10 N
T 9 N

R 10 W | R 9 W

LOCATION IN INDIANA

LEGEND

- CIVIL TOWNSHIP LINE
- PRISON FARM
- SECTION LINE
- SECTION NUMBER 25
- PAVED ROAD
- GRAVEL ROAD
- DIRT ROAD
- FARM ROAD
- RAILROAD
- CROSSING (GRADE)
- HOUSE
- SCHOOL
- CHURCH
- CEMETERY
- CITY
- PERENNIAL STREAM
- INTERMITTENT STREAM
- STREAM DISAPPEARS ON FLAT
- PERENNIAL LAKE OR POND
- SWAMP
- LEVEE
- POWER LINE
- BRIDGE, ROAD
- OIL WELLS
- WATERSHED BOUNDARY
- GRAVEL PIT
- PIPE LINE
- DRAINAGE AREA CONTROLLED BY STRUCTURE
- DRAINAGE AREA ACREAGE D.A.-1047 acs.
- AREA BENEFITED
- REACHES
- FLOODWATER RETARDING STRUCTURE
- STRUCTURE NUMBER (1)
- CHANNEL IMPROVEMENT FOR FLOOD PREVENTION
- MULTIPLE PURPOSE CHANNEL

AUTHORITIES

Prepared by the SCS Cartographic Unit, Milwaukee, Wisconsin from USGS quadrangles: Lewis (1952), Pimenta (1958), Hutton (1952), and General Highway Map of Vigo County (1958).

0 2000 4000 6000 8000

SCALE IN FEET

7-5-63

PRAIRIE CREEK WATERSHED - VIGO COUNTY, INDIANA